



让我们共同打造气候中和的未来
Building a climate-neutral future together

Sino-Swiss Cooperation on Zero Emissions Building

Zero Emissions Building Demonstration Project Report

Hutan Donggou Residential Project

Dalian, Liaoning

ENGLISH VERSION



OCTOBER 2024



中华人民共和国
住房和城乡建设部



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This report has been produced within the framework Sino-Swiss Zero Emissions Building Project; an international collaboration funded by the Swiss Agency for Development and Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development.

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The Sino-Swiss Zero Emissions Building Project is an international collaboration funded by the Swiss Agency for Development Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development. The project aims to reduce greenhouse gas emissions and enable carbon neutral development of the building sector in China by sharing Swiss know-how on sustainable and zero emission building.

Implementation partners:

Intep Integrated Planning
Skat Consulting
China Academy of Building Research

WeChat:

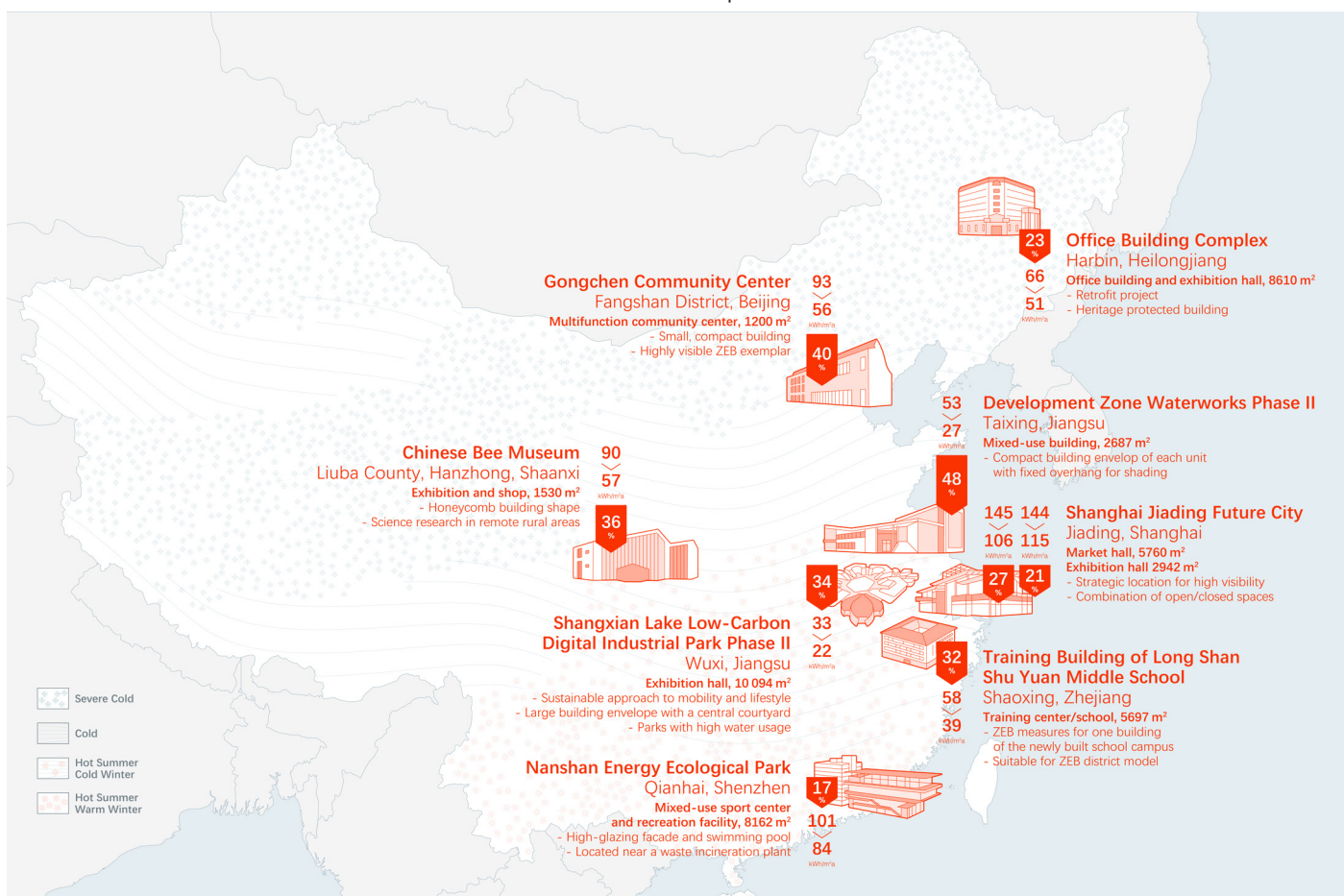


Web:

zeb-china.org

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Map. Zero Emissions Building demonstration projects. Eight projects distributed across China's four climate zones. Image by EBP.



1. Sino-Swiss Cooperation on Zero Emissions Building

To jointly address global climate change and to strengthen cooperation between China and Switzerland in the field of emissions reduction in the construction industry, the Ministry of Housing and Urban-Rural Development of the People's Republic of China and the Swiss Federal Ministry of Foreign Affairs signed a Memorandum of Understanding (MoU) on 24 November 2020. The Memorandum focuses on fostering international cooperation in the field of building energy efficiency. Within the framework of this MoU, the Swiss Agency for Development and Cooperation (SDC) initiated and funded the Sino-Swiss Zero Emission Building (ZEB) Project. The project aims to support China in formulating the technical standard for zero carbon buildings and long-term roadmaps for reducing carbon emissions in the construction industry. Switzerland contributes by sharing know-how, showcasing demonstration projects of zero emission buildings in four different climate zones, and carrying out various forms of capacity building activities to promote the carbon-neutral development of China's construction industry.

Project Objectives

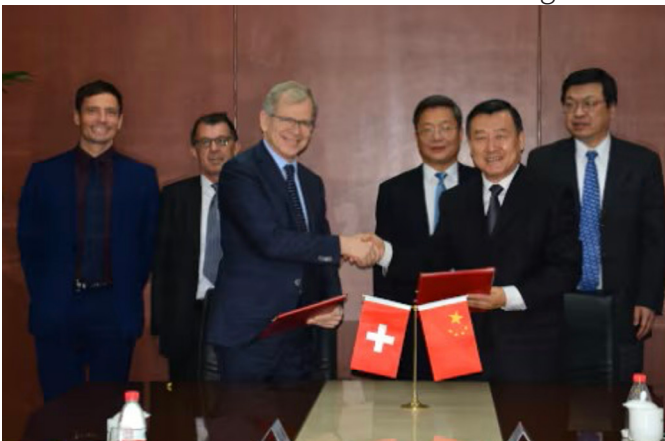
- Upgrading existing building energy efficiency standards to zero carbon technical standards
- Implementing demonstration projects (DP) in four typical climate zones to test the new ZEB standards and finding potential for optimization
- ZEB capacity building and knowledge dissemination

Project duration

March 2021 – November 2025

Project impact on climate protection

Reduce CO₂ emissions in China's building sector.



Ambassador Bernardino Regazzoni and Vice Minister Ni Hong, sign the project agreement. Image: Swiss Embassy in Beijing

Demonstration projects

The ZEB Project supported Demonstration Projects intended to serve as case studies to guide and educate further projects in achieving the ZEB standard.

Following a call for suitable projects, selection of demonstration projects in each of China's four climate zones followed a consistent process including.

Collection of applications for potential demonstration projects by an official call

- Evaluation based on selection criteria by Chinese and Swiss experts:
 - Political commitment, funding commitment, possibility of intervention, potential for affordability and replicability, visibility and accessibility, diversity
 - CO₂ emissions reduction potential and other environmental benefits (40%), number of beneficiaries (20%), light-house potential (20%), incentives by local government (20%)
 - Quick-starter, compatibility with draft ZEB-Standards, pilot characteristics, availability of data
- With Sino-Swiss joint feedback and recommendations, MoHURD announced the selected demo projects in March 2022

Sino-Swiss team

The ZEB team includes Swiss and Chinese specialists. The Chinese DP team first proposed design prototypes and zero-carbon design strategies. After reviewing the design features of the project, the Sino-Swiss expert team gave tailored feedback on the design prototype and strategical concept. The Swiss team also arranged webinars on specific topics based on the questions from the DP team. Ideas contributed by the Swiss experts are based on international experience.

Goals of Sino-Swiss cooperation

ZEB project support to demonstration projects sought to improve the project quality and support compliance with ZEB-standards. The cooperation is mutually beneficial – the Swiss team brings experience and expertise to China, while the Chinese colleagues can share their experiences for the Swiss to learn from. Jointly the Swiss and Chinese teams discover what the best solutions are to develop a successful zero emission building.

2. PROJECT INITIAL STATE

2.1. Project organization

In March 2022, the “Dalian Hutan Donggou Plot Residential Project” was selected as one of the 2nd batch Demonstration Projects of Sino-Swiss ZEB Project. This project is a ministerial-level international cooperation project initiated by the Chinese Ministry of Housing and Urban-Rural Development and the Swiss Agency for Development and Cooperation. The project commenced in Sept. 2022 and is planned to be completed with its construction in 2025.

Investor

- Dalian Shengding Hutan Binhai Real Estate Co. Ltd

Lead planning team

- Urban Development Design Group

Sino-Swiss ZEB international joint consulting team

- Intep, Skat, CABR, Low-tech, UAD, HSLU, EMPA, etc.

2.2. Project overview

Location

- Dalian, Liaoning, China (Cold Area; Solar Resource Area II)

Area

- Gross building area 161030m² (The project includes residential, kindergarten and community commercial facilities)
- Total demonstration area 154' 200m² (residential area 152' 000m² + kindergarten 2' 200m²)
- Energy Reference Area 10388m² (according to ratio of building 1#-135)

Architectural concept highlights:

(see plans in attachment)

- 7-8 storey apartments (Zellenbau) and 2 storey kindergarten (offene Hofbau)
- Compact building volume, pitched roof with PV, balcony as fix horizontal sun shading



Figure 1: Residential project located among natural forest. Source: Project Presentation 17.06.2023 ©Urban Development Design Group



Figure 2: Highlights of the zero-carbon sustainable technology pathway design applied in the project, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

Energy concept:

- Heating: Sewage source heat pump + floor heating end
- Cooling: Sewage source heat pump and water storage tank + air conditioning terminal
- Ventilation: High-efficiency heat recovery mechanical ventilation
- Hot water: centralized sewage source heat pump or decentralized electric boiler (to be decided by the owner)
- Solar: BIPV tiles on the central part of the sloping roof
- Shading: Dynamic external light tracking shading (aluminum blinds) and fixed balconies

Other sustainability concepts:

- Sewage plant capacity: 30' 000 m3 per day
- Cold storage tank for summer cooling
- The Energy Management Center is responsible for energy preparation and storage, and sets up an energy and carbon operation and maintenance monitoring platform.

3. SINO-SWISS COOPERATION

3.1. About the demo Project design team

The zero carbon design team for the Dalian Demonstration Project is Urban Development Design Group, which is well known in the field of near-zero energy consumption and zero carbon buildings in China. The group established the Zero Carbon Building Research Institute in 2012, which is dedicated to the research and practice of zero carbon buildings in all directions, and has mastered the most complete, in-depth and advanced technology system in the industry, with a number of international leading core technologies and more than 50 patented works. Over the years, the company has invested in the design, consulting and construction of a large number of high-quality zero-carbon building cases. The project cases are located in Dalian, Beijing, Shenzhen, Suzhou, Wuxi, Chengdu, Xi'an, Yueyang, Xining, etc., covering different climate zones from cold regions, hot summer and cold winter, hot summer and warm winter, and mild regions.

Among them, the Taicang Zero-Carbon Building Base, which is invested, designed, constructed and operated by Urban Development, has been awarded the three-star certification mark of China's Green Building, the certification mark of China's near-zero-energy-consumption building, the Passive House-Premium certification mark awarded by the German Passive House Institute (the world's first PH-Premium office project), the Austrian Green Planet Award for Building (AGPB), and the Swiss Excellence in Building Award (SEB). AGPB, and the Swiss Building Standard of Excellence Minergie-A Climate Friendly Building (the first Minergie-A certified project in China/CHN-001). After dozens of years, Urban Development has become one of the leading teams in the field of zero-carbon buildings in China with the innovative products and core technologies of zero-carbon buildings precipitated over the years as its competitiveness.

Based on the years of experience in implementing the whole chain of zero-carbon buildings from Urban Development Zero-Carbon Building Research Institute, the demonstration project has provided a perfect energy program planning, energy and carbon calculation and analysis, passive and active technology development and comprehensive implementation of renewable energy applications. The project team consists of professionals in R&D, design, construction, intellectualization and cost-

ing, and is committed to promoting the application of advanced low-carbon technologies at home and abroad on a large scale and with high quality, with the help of design innovation, process research and development, construction control and cost optimization.

Architectural program design is implemented by Grand Elephant Architecture (Beijing) Co.

3.2. First inputs and suggestions

- Swiss team sent a Q&A list of inputs and consulting activities that planned to deliver
- For the evaluation of the ZEB district we recommend to use also the procedure according to Swiss 2000 Watt district.
- For hot water, heat pump is more compatible with the ZEB standard than current solution with gas boiler.
- We recommend to discuss the heating and cooling supply with Swiss experts for energy networks and to optimize it if possible. In this context, sewage plant as an energy source represents an optimal solution.
- A detailed energy and emission calculation must be available from DP team for the ZEB standard.
- For the windows we recommend the use of triple glazing with $U = 0.5$.
- We recommend to enlarge the balcony to 1.80 m depth. This will significantly improve their utility and make them more attractive to buyers.
- For thermal insulation, the use of rockwool would be ecologically and for fire safety better than EPS panels.
- The district should have a microgrid in addition to district heating/cooling. The kindergarden must be included.
- Check out Energy Hub with Sympheny Software
- The room comfort can be fully guaranteed with floor heating/cooling alone (well designed the floor remains neutral all year through, not warm, neither cold.) Maximizing free cooling and minimizing chiller operation by floor cool-

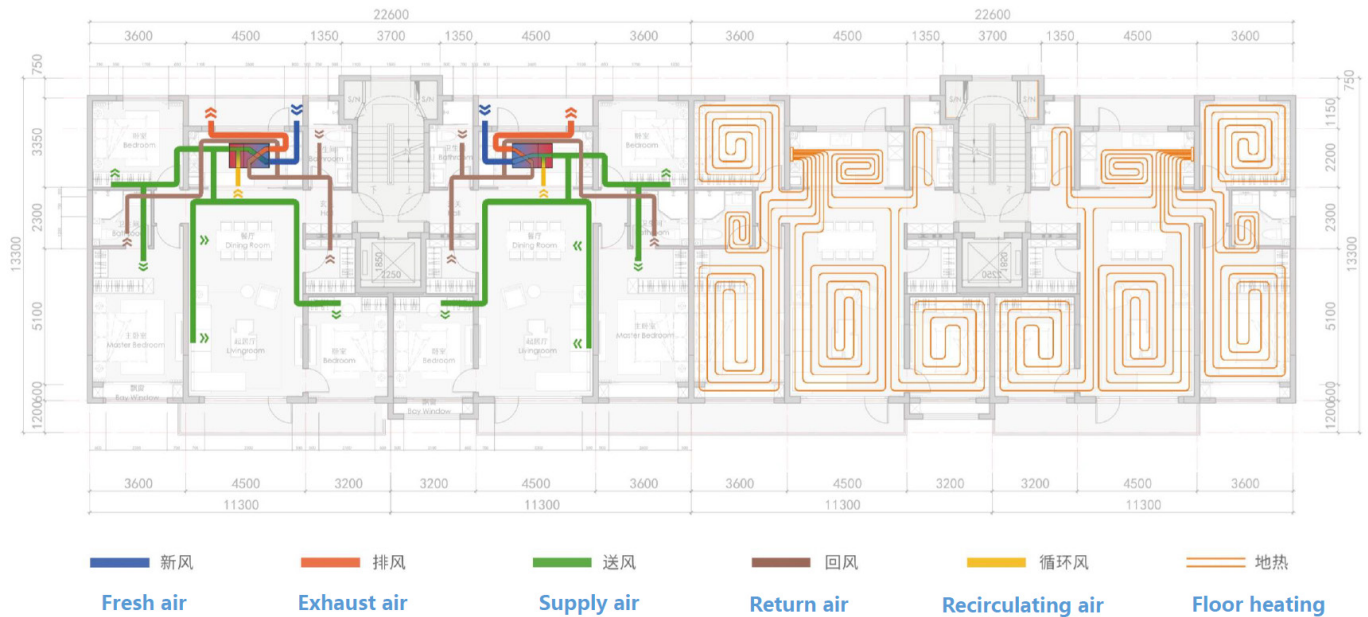


Figure 3: Heating, cooling and ventilation concepts, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

ing with chilled water temperature $> 20^{\circ}\text{C}$ (Floor heating as floor cooling in summer, no condensate on surface, no cold feet).

- Airconditioning does not seem to be economically optimal and could be cancelled. If investor doesn't want take this risk, it is recommended to reserve installation space for airconditioning to the owner of apartment.
- The neighboring sewage treatment plant is energetically very good heat source ($12\text{--}15^{\circ}\text{C}$) with a sufficiently large capacity (30000 m³/day or 350 kg/s).
- PV should be optimized for maximum self-consumption -> various PV orientations for gains at different times during the day. The central heat pump should be able to be operated entirely with the selfgenerated electricity from the photovoltaic. The thermal storage as well as the electricity storage have to be verified and optimized over a 24h cycle of the load and production profiles.
- Biogas from the sewage treatment plant could be used for cogeneration (CHP=combined heat and power) and make the district even more independent.
- Electrical vehicles should be considered in the energy concept as energy storage (batteries).
- We recommend to exclude mechanical ventilation. Ventilation pipes occupy too much installation height. Natural ventilation ist especially comfortable with the inertia of floor heating/cooling.

3.3. Reaction of DP team and concept improvement

DP would try to redesign this project according to Swiss 2000W Areal Standard as follow:

- Kindergarten is included in the whole energy system with sewage-source heat pump. DP is working with sewage plant company to measure and figure out precise data, to ensure the reliability of heat pump in the future.
- The concept of floor cooling has no precedent reference project in China for residential building. Investor will most likely deny this suggestion.
- DP planned to eventually increase PV, in order to cover electricity consumption with PV production.



Figure 4: Location of model housing projects and location of wastewater treatment plants, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

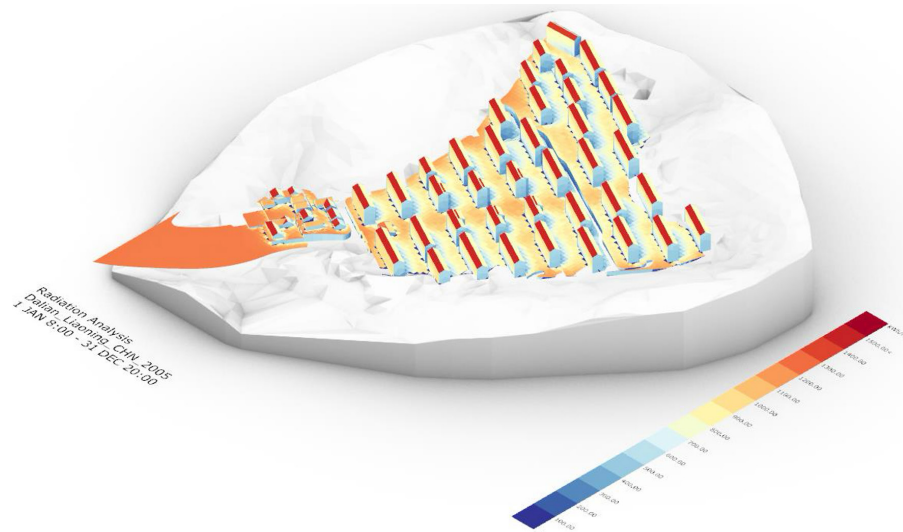


Figure 5: Analysis of solar radiation within the project site, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

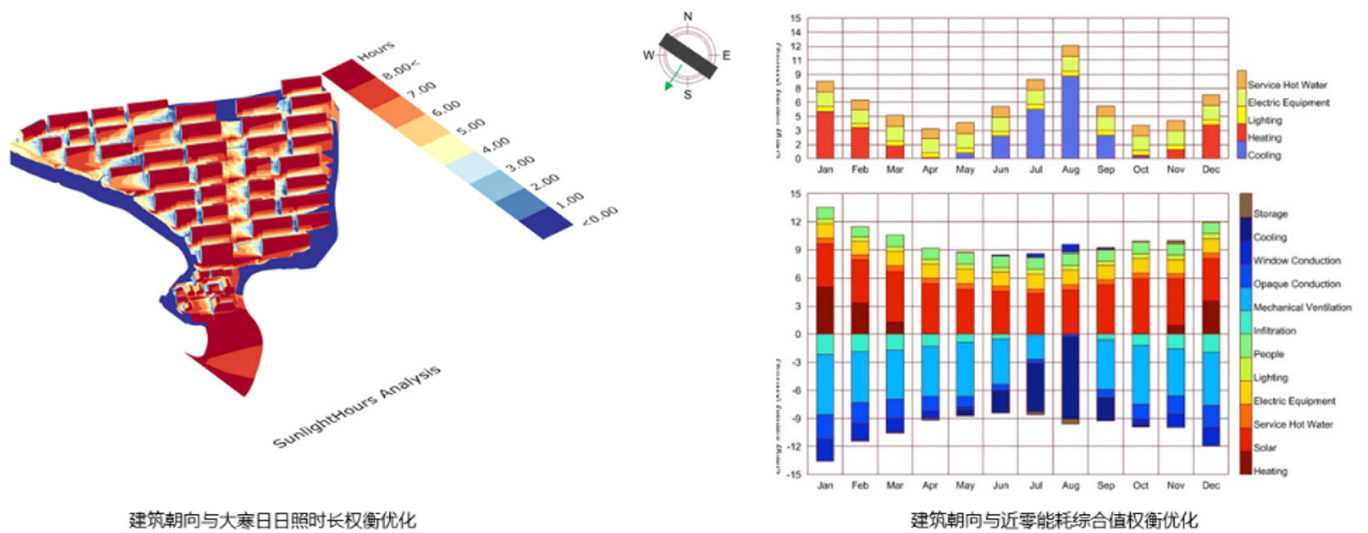


Figure 6: Analysis of trade-offs between building orientation and energy consumption, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

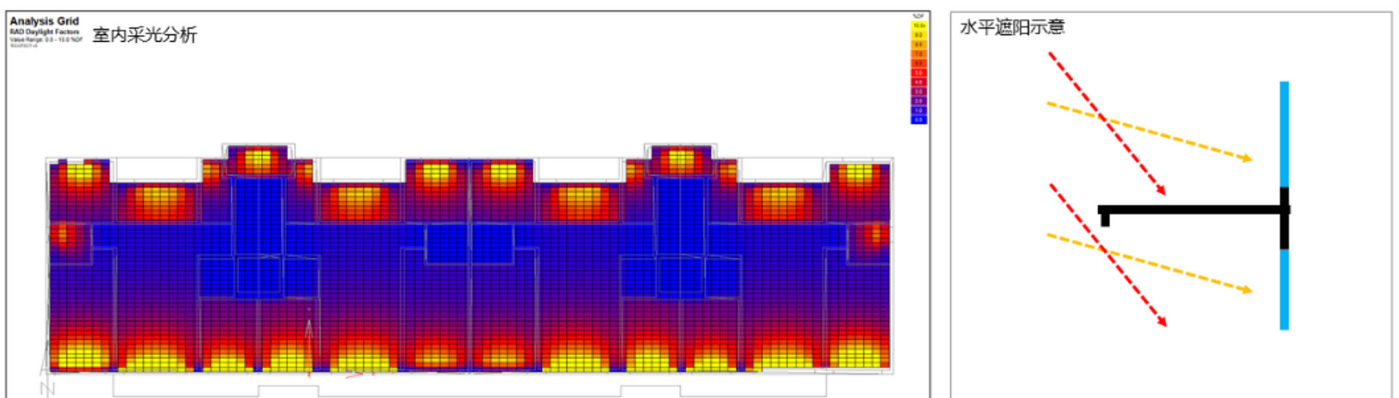


Figure 7: Interior Lighting Analysis, Source: Project Presentation 17.06.2023 ©Urban Development Design Group



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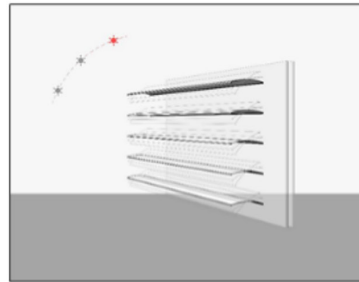


Figure 8: Shading system design, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

遮阳百叶效果



水平固定遮阳区域



外遮阳百叶区域

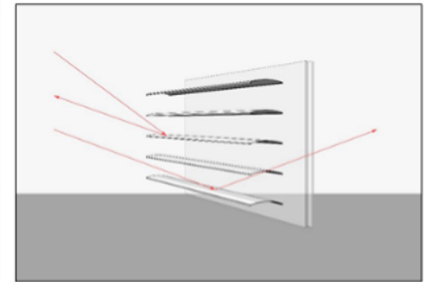


Figure 9: Shading system control logic, Source: Project Presentation 17.06.2023 ©Urban Development Design Group

数字孪生能源系统

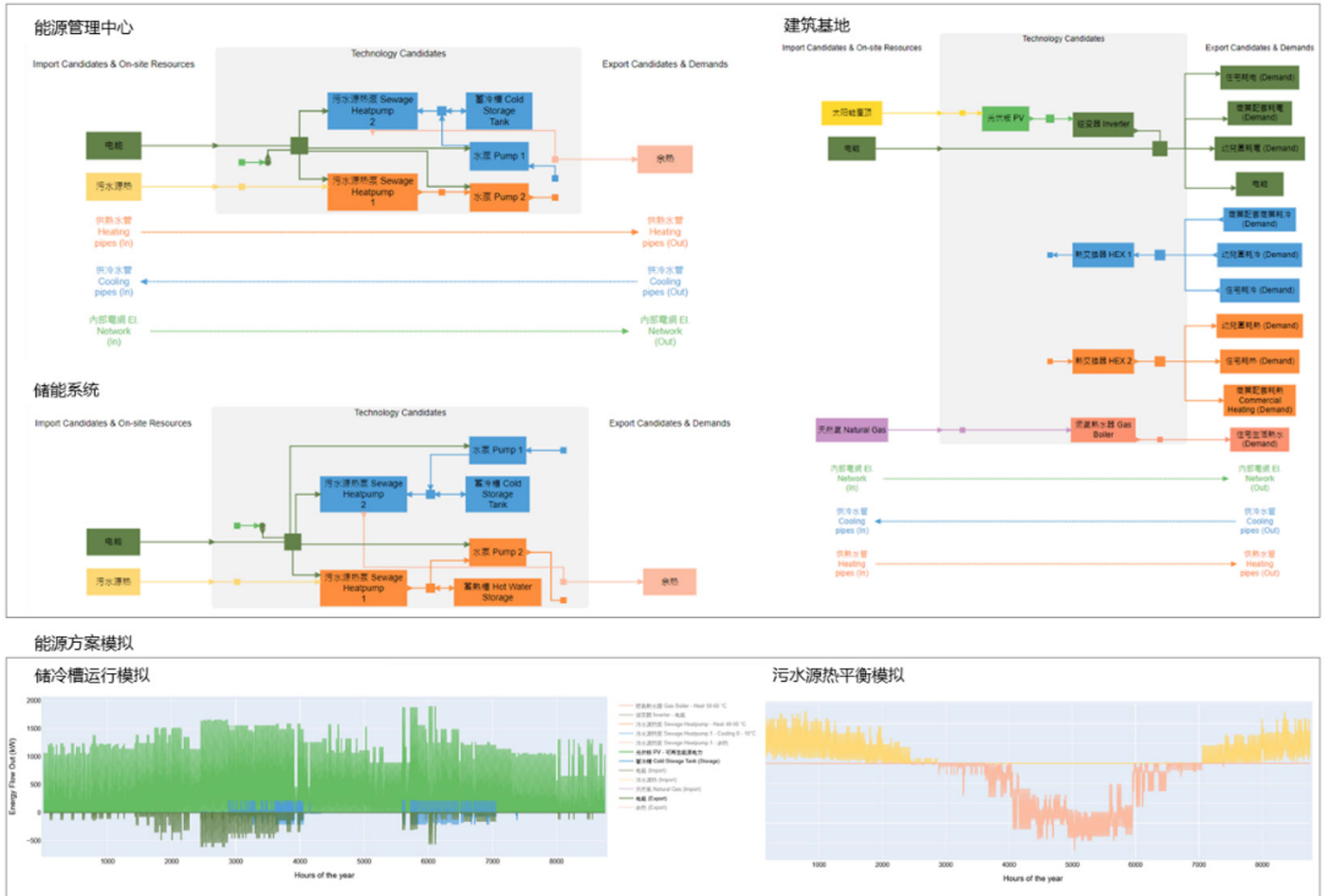


Figure 10: Sympheny Optimization of the overall energy concept for the Dalian Demonstration Project, Source: Sympheny

- The optimization on passive measure, incl. better windows and doors is depended on simulation result.
- DP planned to increase balcony to 1.4-1.5m deep.
- There is no precedent for the concept of using “underfloor heating” systems as “underfloor cooling” systems for summer cooling in residential buildings in China, and housing investors are likely to reject this proposal.
- The design team of the demonstration project will try to increase the number of photovoltaic panels and try to meet the power consumption with self-generated electricity.
- Building passive measures (including better windows and doors) will be further optimized based on energy simulation results.
- Rock wool for façade insulation is more complicated in terms of construction, therefore it has difficulty on construction site and cannot be correctly implemented. The investor insists on EPS for better performance and easier construction.
- DP planned to increase charging piles in parking lots (current plan 10%) to increase battery storage capacity.
- DP cooperated with Sympheny to work with Energy Hub.

3.4. Further Swiss inputs and suggestion

- High performance window/door production with better K-Value (glass and frame)
- Abandon gas boiler for hot water. (cooking still with gas cooking due to Chinese cooking tradition)
- Computational Fluid Dynamics (CFD) Simulation for air flow through the whole area
- Greenery and PV combination
- Zero Emission District
- Anergy Nets with Anex AG
- The incentive policy in China about ZEB or NZEB building is hanging, which make ZEB building and district less attractive to investor
- The workers on construction site should be systematically trained for ZEB construction, in order to improve building quality to reach ZEB goals.
- Some advanced solutions such as floor cooling (free cooling) need to be demonstrated in project, in order to reach ZEB by using advanced technologies and solutions.

3.5. Calculations

Initial Chinese calculation (Building 1#-135m², June. 2023)

- Energy consumption total: 35.2 kWh/m²a
- PV production: 10.34 kWh/m²a

Calculation of Swiss experts (June 2023)

- Energy consumption total: 20.9 kWh/m²a
- PV production: 19.77 kWh/m²a

Improvement of Calculation

Due to the project suspension, further energy consumption simulation calculations could not be carried out.



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4. OUTCOME/REACHES

4.1. Overall evaluation of the project result

Although the project not realized, the Sino-Swiss ZEB Project team still very appreciate that the DP design team gave their best in the planning phase to make the project to reach the ZEB-goal as required in ZEB Standards, especially in the operational phase.

The Sino-Swiss ZEB Project team also very appreciate that the DP design team considered the carbon emission throughout the whole life cycle and did its best to reduce the embodied emission as much as possible.



5. LESSON LEARNED

5.1. Management and Organization

The short design phase in China is very challenging for Swiss expert team. The intensive and constant communication with DP team is crucial for project development. The Swiss team needs to response DPs team as soon as possible and give quick inputs so that the ideas can be adapted into the project in such a short time.

Concrete factors and numbers are more persuading than any other word or theory. With calculation tool developed by Swiss expert for example, the Swiss team can communicate with DP team in a very constructive way.

5.2. Technical Solutions

As the sole residential demonstration project, this initiative provides an excellent opportunity to showcase Zero Emission Buildings (ZEB) in everyday life. Regrettably, due to the current high-risk state of the real estate market in China, the investor has decided to put this project on hold.

Considering the scale of such a project, a district thinking is crucial. To encourage neighboring stakeholders to develop a ZEB district, it's essential that the investor, local authority and planning team collaborate closely from an early phase.

5.3. Communication and Cooperation

The following formats and means of communication were actively used in the project procedure:

Charrettes incl. technical response by the Swiss team

- Kick-off Charrette
- Update Charrette
- Offline workshop and Onsite visit
- Kick-off meeting Building Automation/Smart control

Joint Charrettes with all three DPs from first batch

- ZEB Duty Book
- circular construction
- fire safety of timber structures

- Facility management and ZEB operation
- Zero Emission District
- Computational Fluid Dynamics (CFD) Simulation
- Green PV
- Swiss technologies and products

Rapid technical input sheets (RITS) about

- BIPV solution incl. façade PV and Photovoltaic tiles, local product manufacture recommendation
- KBOB - Swiss Coordination Conference of Building and Property Bodies of Public Sector Developers
- Low carbon cement LC3
- High performance windows and doors
- Facility Management
- Shading Systems and Products
- Greenery and PV

Q&A sheet and further thematic inputs about:

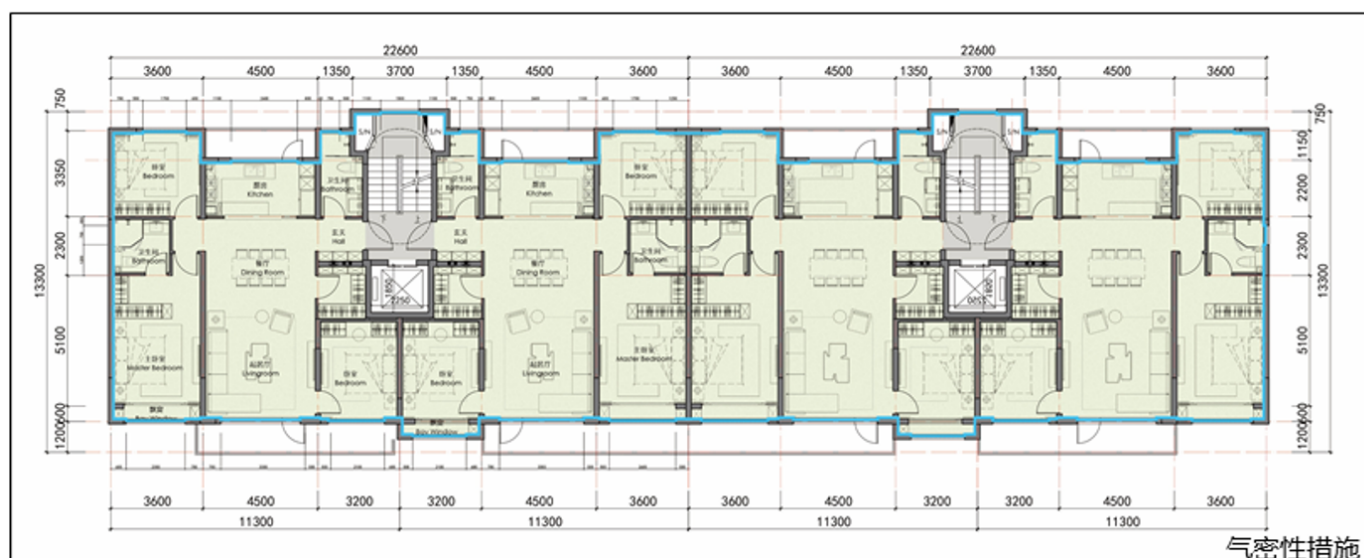
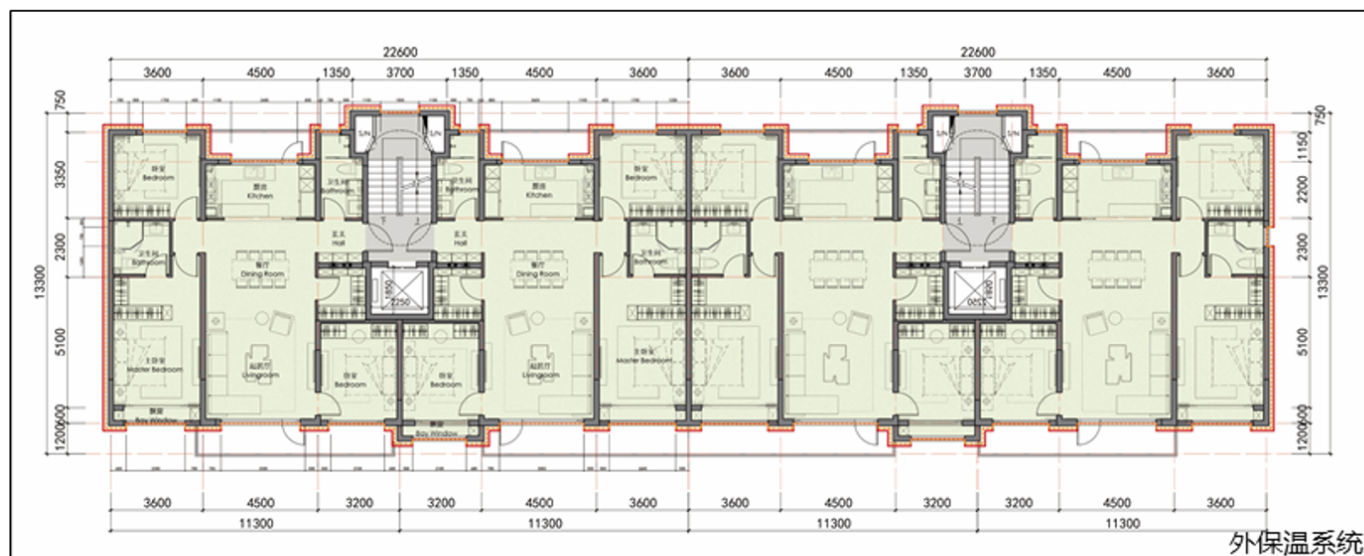
- ISO norm and SIA2040
- U-value / visible light transmission (VLT)
- Heat recovery / air handling unit / AC
- Earth tubes for ventilation system

Further performances

- ZEB Duty Book developed, shared and presented
- Regular exchanges and discussions per WeChat, Telephone and email
- site visit and technical exchange on construction site
- Public and internal ZEB Talks on various ZEB Topics
- Booklet regarding e.g., ZEB policies, regulations, standards, concepts and techniques.
- Exchanges and discussion on events like National NEZB Conferences and the Sino-Swiss Industry University Research
- Collaboration Forum on Zero Emission Building etc.

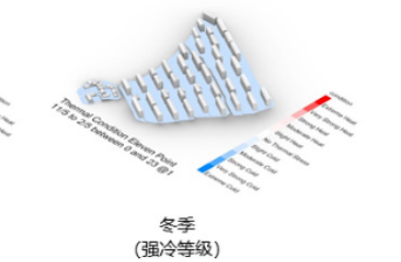
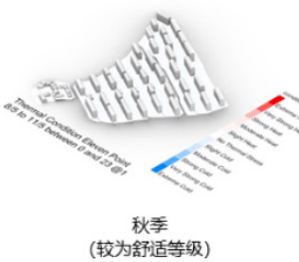
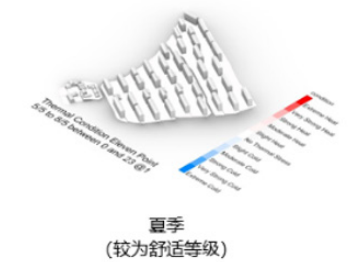
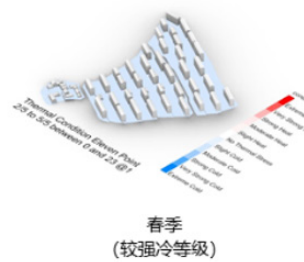
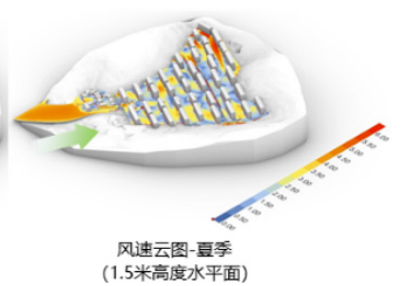
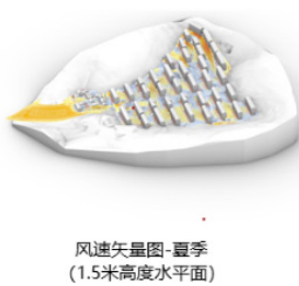
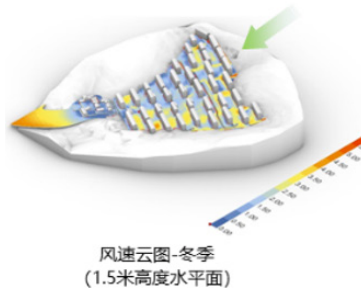
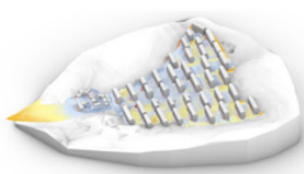
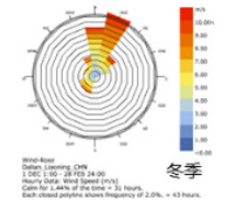
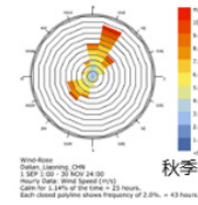
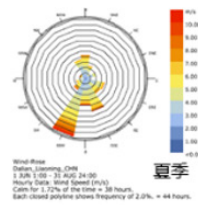
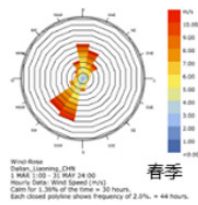
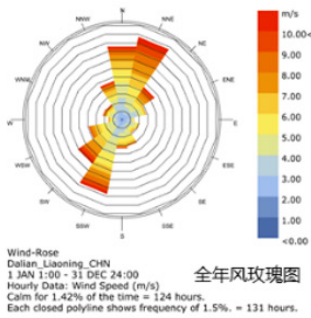
ANNEX 1.

Typical monolithic exterior insulation systems and airtightness measures



ANNEX 2.

Analysis of the climatic environment of the site





ANNEX 3.

Energy consumption simulation data



ANNEX 4.

Cooling and heating system and end, fresh air system, domestic hot water system



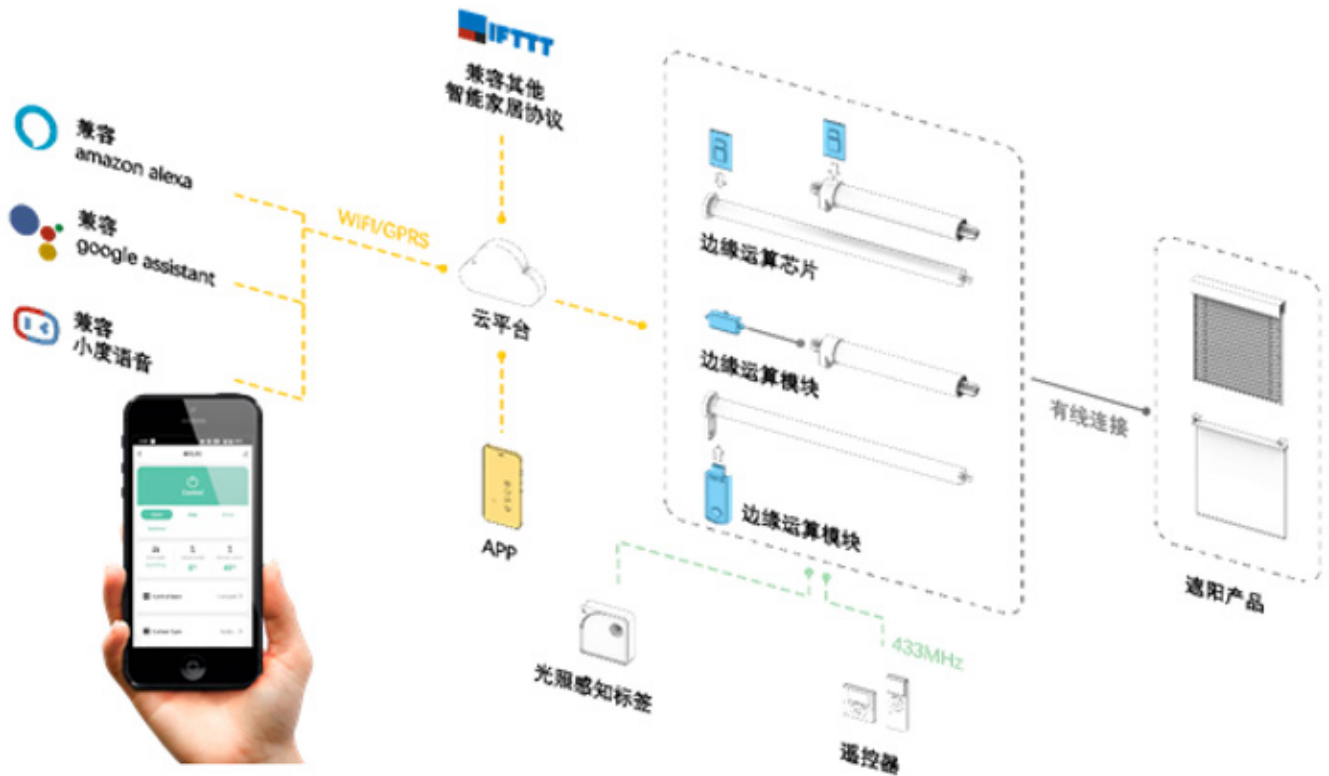


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ANNEX 5.

Intelligent operations and maintenance system

智慧控制系统



智慧管理平台



ANNEX 6.

Glossary

AC	Air Conditioning
AC	Alternating Current
BIPV	Building-integrated photovoltaics
CABR	China Academy of Building Research
CFD	Computational Fluid Dynamics
DC	Direct Current
DP	Demonstration Project
HVAC	Heating, Ventilation, and Air-conditioning
SDC	Swiss Agency for Development and Cooperation
Mohurd	Ministry of Housing and Urban-Rural Development
ZEB	Zero Emission Buildings
Intep	Integrale Planung GmbH
Skat	Skat Consulting Ltd.
UAD	Architectural Design & Research Institute of Zhejiang University
SUP	SUP Atelier (The Architecture Design and Research Institute of Tsinghua University Co., Ltd.)
HSLU	Lucerne University of Applied Sciences and Arts
Low-Tech	Low-Tech Lab GmbH
FHNW	University of Applied Sciences Northwestern Switzerland
ZHAW	Zurich University of Applied Science
Willers	Willers Jobst Engineering AG
MOU	MEMORANDUM OF UNDERSTANDING
Q&A	Question & Answer
RTIP	Real-Time Interactive Platform
PV	Photovoltaics
HVAC	Heating, Ventilation, and Air Conditioning
LC3	Low Carbon Cement LC3
RITS	Rapid technical input sheets
KBOB	Swiss Federal Coordination Centre for Research in the Construction Sector
VLT	Visible Light Transmission
NEZB	Net Zero Energy Building
SIA	Swiss Society of Engineers and Architects
EMPA	Swiss Federal Laboratories for Materials Science and Technology



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